

INVESTIGATING THE POWER IN FREIGHT TRANSPORT COMMUNICATION NETWORK STRUCTURE

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Abstract

The business of freight transportation is undergoing a technological revolution as it moves toward the 21st century. New technologies are being developed and adopted in each mode of freight transportation. The one technology that affects all modes is information technology. Information technology related to the coordination of logistics and supply chain management, has the capability of affecting all the modes in a similar way. This technology in the form of electronic data interchange has begun to automate, and reduce the costs of, paper flow required to move goods from shippers, through carriers and transfer points, to consignees. Surveys of the freight transportation industry indicate that the adoption of EDI has not been nearly universal in any dimension. The paper investigates the structure of the communication system used for transport supply chain.

INTRODUCTION

The supply chain management has carried the integration function concept out of the organisation, since it comprises the chain of participants from suppliers to customers. The organisation itself is part of the whole process, which needs the interaction and contribution of all components. Such an external integration has highlighted the importance of electronic trade and the efficient consumer response techniques.

Inter-organisational systems are essentially pairings of business partners. Each organisation may develop links with more than one important partner, but each link is largely independent of the others. Over time, however, economies of scale have become important, and organisations have tended to develop a technical infrastructure which serves the needs of each of the links. Third parties have grasped the opportunity of making a business of offering services to multiple user-organisations.

The natural result of this increase in sophistication has been the emergence of 'multi-organisational' systems. These can be distinguished from

inter-organisational applications in that they are designed to support multiple linkages with many organisations, and, in principle, with any other organisation with which there is a need to communicate.

THE FRAMEWORK

The framework is being applied in the context of a comparative case analysis of supply relationships in the transport industry. The framework acts as a foundation to examine the production network of supply relationships for international transport.

Taking this network perspective, rather than individual dyadic relationships, offers significant insight at the cost of considerable complexity. To cope with the complexity, we defined our organisation-set as a series of focal networks comprising the document, material and cash flow.

The paper investigates the structure of the communication system used for transport supply chain. The network consisting of 24 different types of companies and 103 interchanged documents has been investigated both with simulation techniques and with network dependent relations. The results represent clear view in the structure of the transport communications network, enabling to describe contribution of network position to the importance, influence, prominence and power of an actor in a network.

With the recent advent of computer-based communication technologies, communication networks have become an important factor in global interaction. The world in the information age may be described as being connected by a lattice of networks.

One consequence of modernization is the increase in time-space compression which makes physical distance increasingly less important in social and business relations. Globalization stretches the boundaries of social and business interactions such that the connections between different social contexts or companies become networked

The goal of analysis is to obtain from the low-level relational data a higher-level description of the structure of the system. The higher-level description identifies various kinds of patterns in the set of relationships. These patterns will be based on the way companies are related to other companies in the network. Some approaches to network analysis look for clusters of individuals who are tightly connected to one another; some look for sets of individuals who have similar patterns of relations to the rest of the network.

Using the social network approach we have determined following :

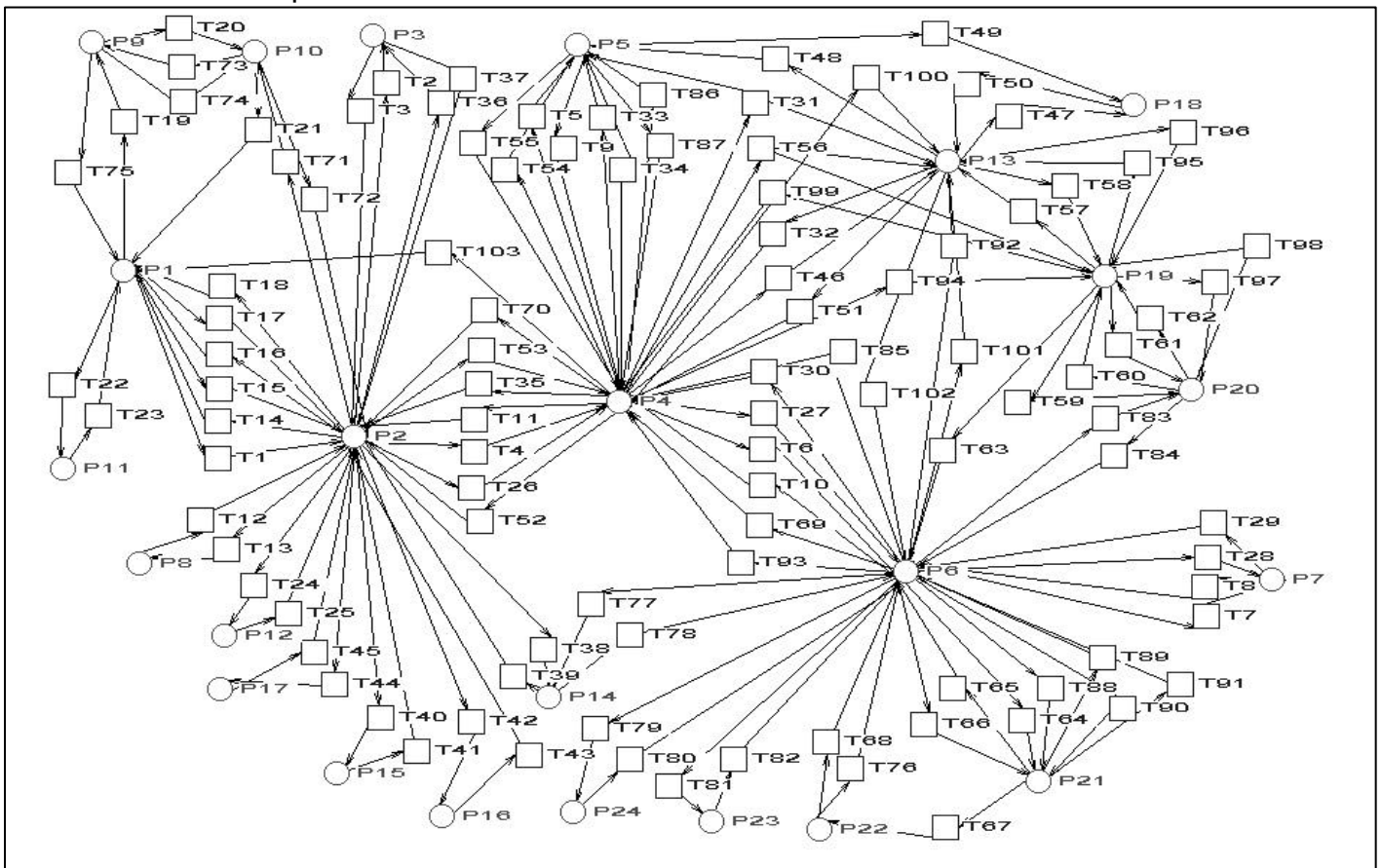
1. The structural position of a company determines its potential for development and its interaction patterns;
2. The structural position of a company is a result of its interactions with other companies;
3. There are two kinds of semiperiphery companies: a) core- like company which are developing core-like dominance in the transport systems; and b) periphery-like company which are losing major dominance in the transport systems;

- The relationships among the companies in the network are relatively stable, changing only as the distribution of the modes of production change.

THE ANALISYS

Units of the analysis are documents (relations) and companies (actors). Relations are characterized by content, direction and strength. The content of a relation refers to the resource that is exchanged.

Pict 1. Representation of the network



One or multiple relations between a pair of actors is called a tie. Pairs may maintain a tie based on one relation only, e.g., as members of the same organization, or they may maintain a multiplex tie, based on many relations, such as sharing information, giving financial support and attending conferences together. Thus ties also vary in content, direction and strength. Ties are often referred to as weak or strong, although the definition of what is weak or strong may vary in particular contexts. Relation categories were derived from a content analysis of the documents interchanged in the transport and supply chain. From more than 200 different documents, 103 are used in model. Network is structured with 103 from 552 possible ties, having thus an average tie density of 19%, with standard deviation of 0,65

indicating heterogeneous distribution of the tie densities in the network. Analyzing transport network alone, the average tie density is increasing to 30% with standard deviation of 0,86. Comparing this data one can infer that the transport part of the network is tightly coupled than sales part of the network.

Network analysis focuses on the relations among actors, and not individual actors and their attributes. This means that the actors are usually not sampled independently, as in many other kinds of studies (most typically, surveys). The results represent clear view in the structure of the transport communications network, enabling to describe contribution of network position to the importance, influence, prominence and power of an actor in a network.

MEASUREMENT OF VARIABLES

Actor Categories. Actors (the companies) in the transport and supply chain are categorized and idealized in order to present normalized tasks in use. 24 different normalized actors were selected for the model. In order to simplify the graphical presentation of the network, graph has been shown at pict 1 and the documents have been presented in addendum 1.

Relation Categories. Relation categories were derived from a content analysis of the documents interchanged in the transport and supply chain. From more than 200 different documents , 103 are used in model.

Network Structure. The structure of the network is shown at picture 1. The thickness of line connecting two actors is proportional with number of the documents interchanged. Arrow at the end of the line represents the direction of the tie. Network is structured with 103 from 552 possible ties, having thus an average tie density of 19%, with standard deviation of 0,65 indicating heterogeneous distribution of the tie densities in the network. Analyzing transport network alone, the average tie density is increasing to 30% with standard deviation of 0,86. Comparing this data one can infer that the transport part of the network is tightly coupled than sales part of the network.

Degree of Hierarchy. The notion of degree of hierarchy is based on the idea that all complex systems, including informal organizations, have a certain level of hierarchy . Krackhardt (1994) developed the measure of degree of hierarchy that indicates the extent to which relations among the individuals in the organization are "ordered," and there is little, if any reciprocity. Krackhardt's measure of degree of hierarchy is defined as $D_H = 1 - [V / \max V]$, where V is the number of unordered or reciprocated links in the organization (A is linked to B and B is linked to A), and $\max V$ is the number of unordered pairs of points (A is linked to B or B is linked to A). A graph that is completely hierarchical will have no "reciprocated" or symmetrical links. Degree of hierarchy in a completely hierarchical network graph will be 1, whereas a completely non-hierarchical graph will be indicated by a score of 0. The hierarchy of the transport and supply chain network is 0,8991, indicating low level of hierarchy.

Centralization. Another measure of structure is centralization. Centralization refers to overall integration or cohesion of a network graph. Centralization indicates the extent to which a graph is organized around its most central point.

There are few different measures of the centrality indicating different kind of measures in the network.

Degree:

Actors who have more ties have greater opportunities because they have choices. This autonomy makes them less dependent on any specific other actor, and hence more powerful. The more ties an actor has then, the more power they (may) have. For example if actor A has more ties, and actor B is tied only with A, if B elects to not provide A with a resource, A has a number of other actors to go to get it, but if B elects to not exchange with A, then B will not be able to exchange at all. One can distinguish in and out degree centrality, depending of the number of the received and despached documents.

Formula for the calculation of the degree centrality is:

$$C_D(p_k) = \sum_{i=1}^n a(p_k p_i) \quad a(p_k p_i) = \begin{cases} 1 & \text{if } p_i \text{ and } p_k \text{ are connected} \\ 0 & \text{if } p_i \text{ and } p_k \text{ are not connected} \end{cases}$$

Where n is number of actors .

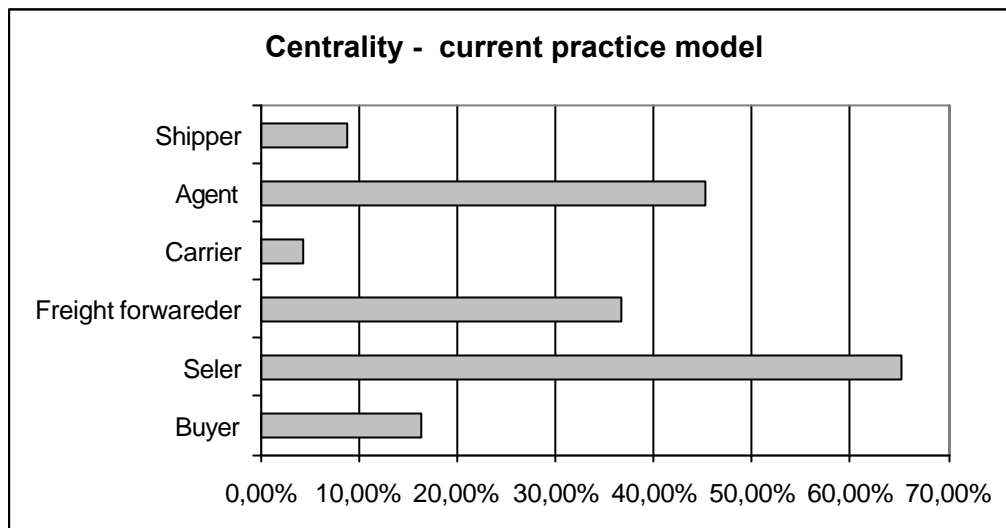
Using this description there are three actors that have biggest centrality : agent , freight forwarder and seller, having normalised out and in degree centrality of 78.26 , 60.87 ; 69.57, 60.87 and 65.22 , 60.87 respectively.

Closeness:

Power can be exerted by direct bargaining and exchange, and it also comes from acting as a "reference point" by which other actors judge themselves, or by being a center of attention who's views are heard by larger numbers of actors. Actors who are able to reach other actors at shorter path lengths, or who are more reachable by other actors at shorter path lengths have favored positions. This structural advantage can be translated into power. . Using this description there are three actors that have biggest closeness centrality : seller, freight forwarder, shipper and agent, having normalised closeness centrality of 62.16 , 60.53, 58.97 and 53.49 respectively.

Formula for the calculation of the closeness centrality is:

$$\bar{C}_{DU}(p_k) = \frac{n-1}{\sum_{i=1}^n d(p_k, p_i)} \quad \text{Where : } d(p_i, p_k) \text{ number of actors connecting } p_i \text{ and } p_k.$$



Pict 2. Centrality

CONCLUSIONS:

Network analysis focuses on the relations among actors, and not individual actors and their attributes. This means that the actors are usually not sampled independently, as in many other kinds of studies (most typically, surveys). The results represent clear view in the structure of the transport communications network, enabling to describe contribution of network position to the importance, influence, prominence and power of an actor in a network

Social network analysis methods provide some useful tools for addressing one of the most important (but also one of the most complex and difficult), aspects of network structure: the sources and distribution of power. The network perspective suggests that the power of individual actors is not an individual attribute, but arises from their relations with others.

The results of the analysed transport and supply chain network indicate that the network is not hierarchical, thus feasible for construction of the virtual organization. The network should be designed between three most powerfull actors – seller, freight forwarder and agent.

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